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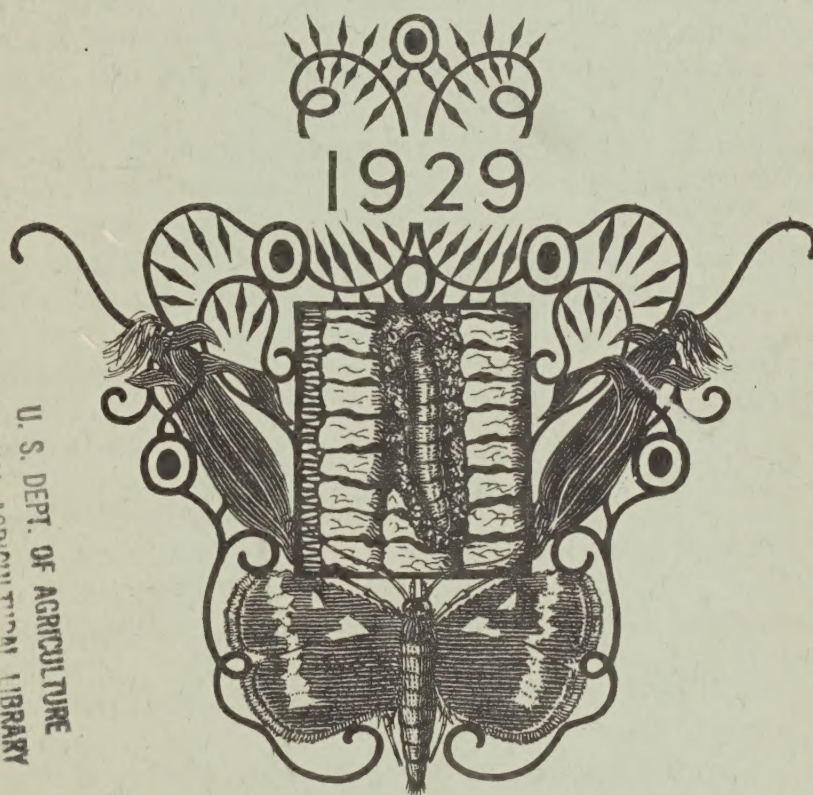


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# COMPLETE RESEARCH PROGRAM

## European Corn Borer



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*United States and Canada*



UNITED STATES  
RESEARCH PROGRAM

REPORT NUMBER

1960-1961

1962-1963

1964-1965

1966-1967

1968-1969

1970-1971

United States and Canada



# RESEARCH CONFERENCE

THE third annual general conference on European corn-borer research is to be held at Washington, D. C., January 2, 1929. The following plans and programs of the Dominion of Canada, United States Department of Agriculture, and the various States have been assembled for discussion and review. At the second annual conference of this nature held at Washington, D. C., in 1928, the following resolution was adopted:

"That the research program as presented by the United States Department of Agriculture and the various States at the Research Conference be adopted as the complete Corn Borer Research Program for 1928, and that a committee be appointed by the chairman to review this program and arrange for desirable allocation of its various phases."

As a result of this resolution, the following committee was appointed and this committee will lead in the review of the combined programs and arrange for appropriate allocation of its various phases:

- G. A. Dean, Kansas (Chairman),  
representing the American Association of Economic Entomologists.
- H. H. Musselman, Michigan,  
representing the American Society of Agricultural Engineers.
- L. E. Call, Kansas,  
representing the American Society of Agronomy.
- C. R. Arnold, Ohio,  
representing the American Farm Economics Association.
- H. G. Crawford, Ottawa, Canada.
- D. J. Caffrey, Toledo, Ohio.
- J. S. Houser, Wooster, Ohio.
- W. P. Flint, Urbana, Illinois.
- R. B. Gray, Toledo, Ohio.

The joint report of the Corn Borer Committees of the American Association of Economic Entomologists, the American Society of Agronomy, the American Society of Agricultural Engineers, and the American Farm Economic Association, was presented at the Fourth Annual Conference of the International Corn Borer Organization, at Toledo, Ohio, September 28 and 29, 1928. The report of this joint committee is included in this program.

Additional copies of this program may be obtained from the Bureau of Entomology, United States Department of Agriculture, Washington, D. C.





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# CANADA







DOMINION OF CANADA





EUROPEAN CORN BORER INVESTIGATIONS

GENERAL PLAN AND PROGRAMME

ENTOMOLOGICAL BRANCH, DEPARTMENT OF AGRICULTURE

FOR CANADA

1929-1930

---

Division of Field Crop and Garden Insects and the Division of Foreign Pests Suppression.

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I. Distribution

(a) Routine annual scouting to determine new territory infested. (In the province of Quebec in cooperation with the Quebec Department of Agriculture.)

(b) Routine annual scouting to determine status of infestation at selected points in infested territory. (In Ontario in cooperation with the Ontario Department of Agriculture.)

(c) The establishment and administration of a quarantine of the infested areas variously restricting the movement of dangerous materials.

(d) The establishment and administration of special restrictions upon seed corn movement.

II. Control (In cooperation with the Province of Ontario).

(a) Invention and test of the best farm-made appliances for preparing corn stalks, stubble and refuse for ploughing. (Cont.)

(b) Study of the most effective methods of preparation of crop refuse for ploughing, by those tools, (power and horse) available on the average farm. (Cont.)

(c) Study of the best combination of farm ploughs and attachments to most effectively and permanently bury the crop refuse upon various soils. (Cont.)

(d) Study of the movement of corn stalks and stubble on the surface of ploughed ground and below ground in relation to culture.





### III. Parasite Control

(a) Importation, rearing and distribution of parasites of the corn borer. (In cooperation with the Bureau of Entomology, U. S. D. A.

(b) Special studies in the biology, technique of rearing and storing in quantity and the distribution of parasites.

(c) Special studies in the establishment of parasites in the field and the recovery of same in nature.

(d) Special studies in the biology of native parasites.

### IV. Life-history, Seasonal Occurrence and Habits

A. Routine annual studies of the field rate of development of all stages of the insect,

(a) in southern and (b) northern Ontario, (c) in Quebec and (d) in New Brunswick.

#### B. Mortality

(a) Winter mortality, above snow line, under snow cover and under ground at selected points in Ontario and Quebec. (Cont.)

(b) Routine annual mortality study in cultivated fields in refuse (1) above and (2) below ground and at (3) time of emergence.

(c) Mortality of larvae after migrating to the surface from ploughings and hand burials and the factors bringing about the reduction in numbers associated with such burial.

(d) Relation between degree of development of larvae and winter mortality particularly in marginal territory. (Cont.)

#### C. Larval Establishment and Survival

(a) A study of the mortality of the early instars and the factors controlling same and its bearing upon degree and rate of increase of infestations in various localities.

#### D. Migration of Larvae

(a) Migration of larvae from below ground to and on the surface after ploughing and hand burials; its extent and relation to the reduction in numbers of larvae associated with proper ploughing. (Cont.)





E. Habits of Adults

(a) Distribution of adults in the individual field and in natural harbors. (Cont.)

(b) Flight habits of adults and factors controlling same in the field.

(c) Egg laying habits of adults and factors controlling the same in the field.



EUROPEAN CORN BORER INVESTIGATIONS

ONTARIO AGRICULTURAL COLLEGE

DEPARTMENT OF ENTOMOLOGY AND ZOOLOGY

I - Control.

A - Testing the comparative value of the following methods of dealing with corn remnants in the field:

- 1 - Cutting the stalks level with the ground and cleaning off all remnants and burning them, without plowing.
  - 2 - Lifting the stalks up by the roots in the spring so as to leave no borers under ground, then gathering and burning, without plowing.
  - 3 - Cutting the stalks low, removing them and then plowing the stubble under completely and gathering and burning any that are dragged up in the spring when cultivating the soil or sowing the next crop.
- B - Improving the present farm implements for dealing with corn remnants in the field and devising new and more effective but not costly implements for the same purpose.





# ENTOMOLOGY







PROPOSED  
PLAN AND PROGRAM  
OF  
EUROPEAN CORN BORER INVESTIGATIONS  
BUREAU OF ENTOMOLOGY  
1929\*

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Arlington, Mass.

Silver Creek, N. Y.

Sandusky, Ohio

Toledo, Ohio

Monroe, Michigan

Hyerres, France

Yokohama, Japan

\* Supersedes and supplements "Programs" of  
1919 - 1928 inclusive.



January 1, 1929.

I - Distribution.

- A - Determination of the actual distribution of P. nubilalis in the United States. (In cooperation with Plant Quarantine Control Administration).
  - 1 - Identification of material sent in by Mr. Worthley's field scouts, quarantine inspectors and other field workers. Includes material from miscellaneous sources. In cooperation with U. S. National Museum.
  - 2 - Adults reared to confirm larval determination when submitted from new widely - separated areas - or from new host plants.
  - 3 - Complete note record of first-found infestation in each township. Complete file of P. nubilalis material from each first-found infestation.

II - Control.

- A - Burning infested material (In cooperation with agricultural engineers).
  - 1 - Details substantially the same as in "1928 Program", including the Heating and Combustion tests.
- B - Steaming infested material (In cooperation with agricultural engineers).
  - 1 - Possible adaptation of portable steam outfits in treating material in field. Detailed study of temperature and time interval requirements, in relation to different steam pressures, and different moisture content of cornstalks, to secure effective larval mortality.
- C - Feeding infested material to livestock (In cooperation with agricultural engineers). (Details same as in "1928 Program").
- D - Plowing infested material (In cooperation with agricultural engineers). (Details same as in "1928 Program").
  - 1 - Special project upon effect of plowing under early sweet corn, in late summer, when stalks are green.
- E - Varietal and seasonal planting (In cooperation with agronomists).
  - 1 - Continuation of cooperative projects with U. S. Bureau of Plant Industry, Mass. Agric. Exp. Station and Illinois Agric. Exp. Station. (Details same as indicated in "1928 Program").
  - 2 - Analysis of applicable data secured during Infestation Surveys.
  - 3 - Continuation of phenological studies.
- F - Status of host plants other than corn. (Details substantially the same as in "1928 Program").
- G - Disposal of infested material in manure pile, barnyard, feed-lot, etc. (Continuation of details indicated in "1928 Program").
  - 1 - Determination of number and percentage of borers surviving, to adult stage, in corn residues from entire stalks, in typical barnyard of Toledo Farm. Portion of barnyard screened just before adult emergence. Borer expectancy determined by detailed





- examination of samples.
- 2 - Determination of percentage of survival to adult stage, by erection of screen cages just prior to adult emergence, by duplicating typical barnyard or feed-lot conditions, under controlled conditions.
- 3 - Systematic observations and examinations on a large series of farms to determine gross facts relative to larval survival and adult emergence under various typical barnyard and feed-lot conditions.
- H - Insecticides (in cooperation and collaboration with U. S. Bureau of Chemistry and Soils; various State workers, Dominion of Canada and Province of Ontario).
  - 1 - Experimental tests (Details same as in 1928).
    - a - Materials - arsenicals, emulsified extracts and water solutions, oil emulsions, silico-fluorides, nicotines - involving carriers, emulsifiers, adhesives, colloids, etc.
    - b - Tests of toxicity, adhesiveness, number of applications, plant tolerance, compatible combinations, costs.
    - c - Application - plot technique, equipment, supplementary adhesives.
    - d - Schedule of applications - number, with reference to development of plant and insect, relation to meteorological conditions.
  - 2 - Laboratory investigations. (Details same as in 1928).
    - a - Chemical tests.
    - b - Biological tests.
    - c - Relation of insecticides to feeding habits.
  - 3 - Trial field tests.
    - a - Efficiency with respect to plant tolerance.
    - b - " " " " costs.
  - 4 - Commercial field tests. (Same details as in 1928).
  - 5 - Field tests of the more promising materials at Toledo Farm.
  - 6 - Tests of new insecticides in cooperation with U. S. Bureau of Chemistry and Soils.
  - 7 - Collaborative insecticide program with various interested State workers, Dominion of Canada and Province of Ontario.
- I - Storage of cornstalks.
  - 1 - Same details as indicated in "Program" for 1928. Continuation of experiments with baled cornstalks in cooperation with agricultural engineers.
- J - Trap crops. (Same details as in 1928.)
- K - Miscellaneous control projects.
  - 1 - Same details as indicated in sections 1 to 5 inclusive in "1928 Program".
  - 2 - Continuation of project relating to two large screened areas, each 1-acre in size, on Toledo Farm.
    - a - One area plowed cleanly.
    - b - One area plowed poorly.
      - (1) - Borer expectancy determined in each area before plowing. Cages erected just prior to adult emergence. Dismantled at end of moth flight period. Dissection of all corn grown in areas at end of season to determine resultant





borer population. Yields and borer population compared with check area grown adjacent to screened area. Comparisons of temperature, humidity, precipitation and light, inside and outside cage.

- 3 - Continuation of project to determine progressive larval population on surface of plowed fields, from early to late spring.
- 4 - Continuation of project to determine importance of migration of larvae from or to corn in shock, under field conditions.

### III - Life History, Seasonal Occurrence And Habits.

#### A - Life History.

- 1 - In the Middle West. Same as in 1928.
- 2 - In New England. " " " "

#### B - Seasonal Occurrence.

- 1 - In the Middle West. Same as in 1928.
- 2 - In New England. " " " "

#### C - Habits (Larvae)

- 1 - Migration - Sections a to k, same as in 1928.
- 2 - Hibernation - " a to e, " " " "
- 3 - Mortality - " a to b, " " " "
  - a - Mortality during establishment of the young larvae.
    - (1) - Experimental studies.
      - (a) and (b), same as in 1928.
      - (c) - Relative mortality of young larvae hatching from eggs deposited naturally on Leaming, Red Cob Ensilage, Northwestern Dent, Golden Bantam, Red Evergreen and a typical Flint corn; planted approximately April 20, May 10 and May 30 respectively, in duplicate plots at random throughout the experimental field.
      - (d) - Relative selection for oviposition on Leaming field corn, planted on the same and different dates.
    - (2) - Field observations. Same as in 1928.
  - b - Continuation of field observations upon influences affecting mortality or survival of young larvae, including meteorological, cultural, etc.
  - c - Continuation of observations upon migration of newly hatched larvae.
- 4 - Tropic response in larval instars.
  - a - Laboratory experiments.
    - (1) - Identification of tropic reactions.
    - (2) - Sequence of tropic reactions.
    - (3) - Influence of response complex phenomena on tropic reactions.
    - (4) - Measurement of repellant and attractant values in response phenomena.
  - b - Field experiments.
    - (1) - Relation of response to planting method.
    - (2) - " " " " insecticide application.
- 5 - Low temperature relations.
  - a - In roasting-ear sweet corn (checking commercial practice).



- (1) - Effect of controlled abnormally low temperatures for varying periods of exposure and at various stages of borer development.
- b - In seed corn.
  - (1) - Exposure of hibernating larvae to low temperatures for varying periods.
  - (2) - Investigation of low temperature limit in hibernating larvae.
- D - Habits (Adults).
  - 1 - Selection of plants for oviposition.
  - 2 - Continuation of studies relative to oviposition habits of adults as affected by meteorological conditions.
  - 3 - Continuation of studies relative to natural dispersion as affected by wind movement.
  - 4 - Tropic response (cooperation with Boyce-Thompson Institute for Plant Research). Same details as in 1928.
    - a - Chemotropic response in adult.
    - b - Relation of chemotropism to the normal complex of P. nubilalis.
    - c - Field investigations of attractant and repellent substances in the Middle West (one generation) and in New England (two generations).

#### IV - Dispersion And Economic Surveys.

- A - Continuation of studies indicated in 1928 Program.
- B - Relation of artificial and common carrier to dispersion.
  - 1 - Continuation of investigations relative to transportation of all stages of P. nubilalis in commercial products.
- C - Relation of water-drifts to dispersion of infested host plants or waste commercial residues. Same details as in 1928.
- D - Dispersion as indicated by status of infestation. Same details as indicated in previous Programs.
  - 1 - Continuation of field surveys in selected, representative townships in older portions of each infested area (New England, eastern New York, Long Island, western New York, Ohio and Michigan). Such surveys to be made in same or nearby farms each year.
  - 2 - Same as above, to include entire infested district of each main area, inside the "zero border", on basis of 5 fields per township.
  - 3 - Continuation of field infestation surveys in host plants other than corn (in New England).
  - 4 - Continuation of special field survey in New England in commercial sweet corn fields, just prior to harvest.
  - 5 - Continuation of special infestation surveys in susceptible weed hosts.
  - 6 - Classification of infested areas according to intensity and character of infestation, with special reference to comparative infestation in corn and in other host plants, including the size of area involved in each class. Applies to Middle West and New England areas.
  - 7 - Special preclean-up surveys in a limited area of each of the main areas detailed under IV-D-1. To determine borer population





before clean-up, or farm disposal.

- 8 - Special surveys after clean-up, or farm disposal, to determine borer population. Analysis and classification of resulting data to determine comparative efficiency of each method of clean-up, or farm disposal, with reference to crop residues and borer population remaining in such fields. This survey is confined to fields indicated in preceding section (IV-D-7).
- 9 - Continuation of statistical studies pertaining to distribution of larvae in individual fields: to determine adequate samples for infestation surveys and the probable errors involved.
- 10 - Indirect injury and commercial loss to corn and other crops.
  - a - Analysis of above surveys to compute probable economic losses involved.
  - b - Special study of resulting economic damage to corn by different borer populations. (In cooperation with agronomists and soils specialists of U. S. Bureau of Plant Industry and Ohio Agric. Exp. Station).
    - (1) - Secure weights of stalks and ears of 300-plant samples of a uniform strain of Clarage planted on three different levels of soil productivity, each sample containing, on the average, 0, 4, 8, 12 and 16 borers per plant.
      - (a) - At Sandusky, Ohio, on very fine sandy soil.
      - (b) - East of Sandusky, Ohio, on loam soil derived from shale and sandstone formations.
      - (c) - At the Toledo Farm, on clay loam soil derived from limestone formations.
  - c - Special project to determine actual loss in weight, quality and feeding value (nutrients) of corn produced by P. nubilalis infested plants.

#### V - Host Plants.

- A - Continuation of complete host plant lists and classification. Same details as in previous Programs.
  - 1 - Continuation of investigations relating to suspected host plants.
  - 2 - Continued studies of plants exhibiting toxic or repellant properties.
  - 3 - Continuation of isolation cages containing typical host plants of P. nubilalis, other than corn, (beets, dahlias, hemp, Polygonum, Xanthium, Ambrosia, Artemisia) to determine ultimate effect of such host plants upon the insect and whether host plant races exist. Also whether species could persist for an indefinite period in the absence of corn.
- B - Seasonal abundance of P. nubilalis in each of the more important host plants.
- C - Portions of plant attacked as related to seasonal growth of plant and the seasonal development of P. nubilalis.
- D - Duration, extent, nature and appearance of infestation.
- E - Proportion of plants attacked in heavy, medium and lightly infested areas.



- F - Relation of different plants to vitality and future development of P. nubilalis (as indicated under V-A-3).
- G - Exhibit material.
  - 1 - Continuation of details indicated in previous Programs, including a complete herbarium showing summer and winter condition of all host plants; preserved specimens showing typical injury; photos of such plants showing typical infestation; preparation of large and small Riker mounts and similar exhibition material.

#### VI - Investigations In The Orient.

- A - Continuation of same details indicated in "1928 Program".
  - 1 - Biological observations.
  - 2 - Economic "
  - 3 - General ecological observations.
  - 4 - Parasites and other natural enemies.
    - a - Shipment to the U. S. of those species which investigation may demonstrate as suitable for trial.

#### VII - Natural Enemies.

- A - Parasites (Investigations in U. S.).
  - 1 - Foreign - Same details as in "1928 Program".
    - a - Continued importation of desirable species from Europe and the Orient.
    - b - Continued liberation of all adults not required for laboratory breeding, at selected points infested by P. nubilalis. Special stress upon precautions to prevent escape of hyper-parasites.
    - c - Continued allotment of quota of imported parasite material to cooperators in Canada.
    - d - Continuation of large-scale breeding campaign, of all such parasite species for which a satisfactory breeding technique has been developed. The liberation of such material at points indicated under VII-A-1-b.
    - e - Continuation of investigations to develop, or perfect, breeding technique for such parasite species not yet satisfactorily solved, through a critical, practical study of their biology.
    - f - Perfection and improvement of existing breeding methods, to increase efficiency and economy.
    - g - Continuation and expansion of projects for the recovery of imported parasite species, in all areas, with special reference to direction and velocity of dispersion, and percentage of host parasitized.
    - h - Continuation of life-history, seasonal occurrence, habits, host relationship, and other important biological reactions of each imported parasite species.
    - i - Continuation of investigations to determine the reaction of imported parasites, particularly their survival, to various common control practices directed against P. nubilalis.





- 2 - Native parasites. Same details as in 1928.
  - a - Continuation of observations, systematic collections, and comparisons re native parasites of P. nubilalis.
  - b - Laboratory breeding of Trichogramma evanescens Wesm.
    - (1) - Continued test rearings, field liberations, systematic observations for recovery, determination of costs and possible application as a supplementary control measure.
  - c - Continuation of special collections in the field to determine economic status of T. evanescens as a natural enemy of P. nubilalis.
  - d - Continued taxonomic and morphological studies of reared material.
    - (1) - Systematic grouping of reared individuals.
    - (2) - Study of morphological characters to aid in their identification and separation from imported species. Involves a photographic study.
    - (3) - Preparation of material for reference to group specialists.
  - e - Continuation studies of native, or imported parasites, attacking insects other than P. nubilalis, which parasites are, or may later, become parasitic upon the corn borer. To aid in the identification and separation of various developmental stages of parasites found attacking P. nubilalis. Particularly important in the instance of boring insects possessing habits quite similar to that of P. nubilalis.
  - f - Continuation of critical studies re the economic status and abundance of native parasites recovered from Parasite Conservation cages, with due allowance for their assignment to the proper host, as determined by isolated, individual rearings. Special attention to the comparative status of each native species from year to year, as a natural enemy of P. nubilalis.

B - Parasites (Investigations in Europe).

- 1 - Distribution.
  - a - Continued checking of recorded distribution in so far as this can be done when scouting for parasites. Shall probably cover Holland, Scandinavian Peninsula, Lithuania, and Estonia this year.
- 2 - Seasonal History.
  - a - Continued collection of data in Hungary, Yugoslavia, Italy, France, and Belgium.
    - (1) - Towns will be selected over the entire region representing special environmental differences, as has been done in the past. Special collections and field studies will be made at these points.
    - (2) - Data will also be collected to show the transition zones between areas of one and two-generation seasonal history.
      - (a) Data will be collected in the transition zones for the purpose of studying meteorological conditions in connection with seasonal history and number of generations.
      - (b) In any area visited particular attention will be paid to the collection of such information as might lead to a knowledge concerning the reactions of the insect to



certain distinct types of environment.

3 - Abundance and Damage.

a - A two months survey will be made in the Danube Basin in September and October, and data will be collected in Italy and France as has been done in past years to determine abundance and economic importance of the borer. A special survey will be made in the Lower Po Valley Pump lands to determine the extent of infestation and damage, and its correlation to climatic conditions, as expressed by plant associations (or ecological groups).

- (1) - The collection of this data will include all those points mentioned in the main plan of work.
- (2) - Data upon the infestation in other economic crops than corn.
- (3) - Similar observations will be made to determine the infestation in such plants as related to heavily infested corn.
- (4) - Observations to be made upon the infestation in weeds following a similar plan.

4 - The determination of economic and non-economic host plants.

5 - See special section on Parasites.

6 - Natural Enemies other than Parasites.

a - No special researches will be made but the point will be borne in mind during our investigations and collections.

7 - Control.

a - Observations will be made (as heretofore) on the effectiveness of control practices of all sorts, such as practices actually designed to combat the borer and auxiliary practices which have an influence on abundance; for instance, cultural practices (i.e., planting dates, disposition of stalks and stubs, varieties, etc.). This to apply to the Danube Basin, northern Italy, the Jura corn-growing region of France, and the southwestern corn-growing region of France.

C - Parasites (Investigations in Europe).

1 - Continuation of large-scale collections for shipment to America.

The following species will be collected and shipped this year:

Masicera senilis  
Zenillia roseanae  
Exorista mitis  
Eulimneria crassifemur  
Angitia punctoria  
Chelonus inanitus  
Microgaster tibialis  
Apanteles thompsonii  
Macrocentrus abdominalis  
Phaeogenes planifrons





- 2 - Studies on cold storage and packing methods in relation to shipping of cocoons and parasitized larvae.
- 3 - Studies of the abundance of all species of parasites attacking the borer in each faunal zone of France, northern Italy, and the Danube Basin in relation to the value of such parasites as controlling factors for P. nubilalis.
- 4 - Scouting new areas for new parasites or better places to collect already-known species. This work will be confined this year - if funds are available - to Belgium, Holland and Scandinavian Peninsula.
- 5 - Continued scouting for better collecting areas in regions already studied of France and Italy, and the Danube Basin.
- 6 - The study of the effect of various cultural practices and meteorological conditions on the abundance of the various species of parasites in the various faunal, floral, or climatic zones of the Danube Basin, Italy, and France.
- 7 - The study of the biology and morphology of the following species of parasites with a view to breeding in quantity those species not yet being bred and of learning how better to handle the collection, shipment, mating, and liberation of all species:

Apanteles thompsonii  
Macrocentrus abdominalis

<u>Microgaster tibialis</u> )	These 3 will not (?) be finished this year.
<u>Exeristes roborator</u> )	
<u>Chelonus inanitus</u> )	

Phaeogenes planifrons.

- D - Parasites (Investigated in the Orient).
- 1 - Procedure indicated under VI-A-1 to 4.
  - 2 - Continuation of parasite shipments according to results of investigations to determine desirable parasite species of P. nubilalis in the Orient, their biology, interrelationships, economic status, etc.
  - 3 - Procedure with parasite material from the Orient has been indicated under VII-A-1-a to i, inclusive.
- E - Predators.
- 1 - Insects, spiders, birds, animals, etc.
    - a - Continuation of investigations relating to the economic status of each of the above as natural enemies of P. nubilalis.
    - b - Special project to determine control measures, specific identity and general biology of spiders destroying parasites of P. nubilalis in Parasite Conservation cages.



VIII - Disease.

- A - General observations re mortality of P. nubilalis larvae, possibly attributable to disease, in the field or in rearing cages.

IX - Miscellaneous.

- A - Continuation of general biological studies, and collection of exhibit material, of insects commonly mistaken for P. nubilalis.
- B - Laboratory methods and technique. Same details as in "1928 Program".
- C - Taxonomy.
  - 1 - Preparation and preservation of material for study or exhibition.
  - 2 - Arrangement and care of working collections.
- D - Statistics.
  - 1 - Crop losses.
  - 2 - Weather reports and similar data.
  - 3 - Maps.
- E - Photography - including Motion Pictures.
  - 1 - Apparatus and experimental equipment.
  - 2 - Drawings, maps, signs, etc.
  - 3 - Infested plants, and portions thereof, showing typical injury.
  - 4 - Parasites and technique employed.
  - 5 - Associated insects and their typical injury.
  - 6 - Control operations, including operation of various equipment, results of such operation, educational photos, etc.
  - 7 - Completion of special motion picture project, showing all phases of parasite investigations.





# BUREAU OF AGRICULTURAL ECONOMICS





BUREAU OF AGRICULTURAL ECONOMICS.





Studies relating to the Corn Borer to be made by the  
Bureau of Agricultural Economics

1. Analysis of types of farming in the corn borer areas of the eastern Corn Belt will be continued in 1929. Districts with similar systems of farming will be outlined and the relative importance of corn on farms of different types and sizes will be determined. This basic picture of systems of farming in the various districts will be used in formulating subsequent farm management and cost studies relating to adjustments in farm practices and organizations made necessary by the corn borer.
2. A study of successful farms of various types in an area where the acreage of corn per farm and the percentage of corn husked from the standing stalk are larger than in most of the present-infested area. The most advantageous ways in which to change farm practices to control the borer will be determined in the light of the best rotations, soil treatment, the kind of livestock kept, the most effective means of handling livestock and the best means of utilizing farm power, machinery and equipment on these successful farms. The work will be done in cooperation with the Experiment Stations and the various Federal Bureaus.
3. A study of the labor and power required by the various control methods being developed. Data will be obtained from typical localities in important districts in the infested area in the eastern Corn Belt and analyzed so as to determine the methods of control which are most economical for particular circumstances under actual farm conditions. The use of machines and equipment that have recently been developed by agricultural engineering agencies would be given special consideration in this study.

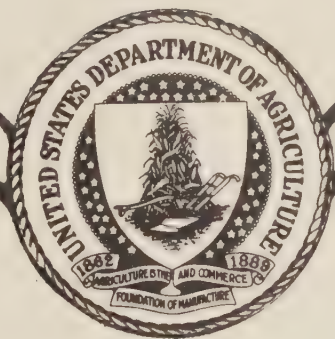


4. A study to determine the conditions under which it will be advantageous for farmers to substitute other crops for all or a part of their corn acreage. In this connection the following factors would be considered:  
(1) possible damage by the borer and reduction in the yield of corn (2) increased labor and power for growing corn under corn borer conditions (3) possible reduction in yields of other crops because of delayed seeding or changes in methods of preparing the land and (4) relative returns for corn and other crops. This includes a study of the outlook for such crops as sugar beets, canning crops, soybeans, alfalfa and other feed crops and the way they would fit into present cropping systems. The experience of farmers in Ontario, Canada, in increasing the acreage of tobacco, sugar beets and canning crops due to the reduced corn acreage on account of the corn borer will be considered in connection with this study.





# ANIMAL INDUSTRY





BUREAU OF ANIMAL INDUSTRY





BUREAU OF ANIMAL INDUSTRY, ANIMAL HUSBANDRY RESEARCH

A Study of Adjustments in Livestock Production Practices made necessary by the advent of the European Corn Borer.

A - Studies on investigations to date and results accomplished.

- 1 - Study of the husker-shredder requirements and utilization of shredded stover in livestock production has been carried on with the Bureau of Agricultural Economics and the Bureau of Plant Industry and State experiment stations in Michigan, Ohio, and Illinois. Manuscripts for a technical and a farmers' bulletin, based largely on the data secured in this study, are now in the process of publication.
- 2 - In cooperation with the Bureau of Plant Industry a working plan has been effected and land has been selected, plowed, and is now being seeded for a study of the greater use of pasture crops in livestock production, to study the effect of a reduction of the corn requirements upon the economy of production and quality of products produced.
- 3 - In cooperation with State agricultural experiment stations and the Bureau of Agricultural Economics obtaining specific information on prevailing methods of raising and handling beef cattle to meet market requirements with a maximum of pasture and a minimum of corn and at the same time make satisfactory returns to the producer.

B - Investigations under way and proposed under this project:

- 1 - Determination of the requirements and costs of using the husker-shredder and the storage and use of shredded stover in the north-eastern part of the Corn Belt.
- 2 - A study of the greater use of pasture crops in cattle and sheep production to effect a reduction in the corn requirement.
- 3 - An economic study of beef production, involving the use of supplemental feeds on pasture.
- 4 - The effects of control measures now used in combating the corn borer on the economy of swine production.
- 5 - The effects of decreased corn production with reference to substitute grains and greater use in pasture crops.
- 6 - The effects on change in type and market weight of hogs.
- 7 - The effects of changed feeds on quality and desirability of meat produced.



# BUREAU *of* CHEMISTRY AND SOILS





BUREAU OF CHEMISTRY AND SOILS.





## BUREAU OF CHEMISTRY AND SOILS

### INSECTICIDES

1. Chemical analyses of insecticides used by the Bureau of Entomology in its various laboratory and field tests.
2. The determination of the solubility, rate of solution, crystal size, apparent density, and other physical properties of insecticides being tested by the Bureau of Entomology.
3. The synthesis of new insecticides to be tested by the Bureau of Entomology.

### SOILS

1. Utilization of Cornstalks.
  - (a) - A survey-evaluation of the more promising uses, with especial reference to those that have received comparatively little attention heretofore, not neglecting, however, to keep in close touch with the progress of work on utilization for building and insulation board, paper and cellulose.
  - (b) - Reevaluation of the fertilizer value of cornstalks to the farmer.
  - (c) - Compilation of data on the feeding value of cornstalks.



BUREAU OF PLANT INDUSTRY.





# BUREAU *of* PLANT INDUSTRY





BUREAU OF PLANT INDUSTRY

BUREAU OF ENTOMOLOGY, U. S. DEPARTMENT OF AGRICULTURE,

and

VARIOUS STATE AGRICULTURAL EXPERIMENT STATIONS COOPERATING.



BUREAU OF PLANT INDUSTRY

AGRONOMIC RESEARCH, CEREAL CROPS AND DISEASES

1. Investigations in heavily infested areas (Cooperative with the Bureau of Entomology and the Ohio Agricultural Experiment Station. Calendar year 1929).

1. Varietal trials, combined with rate and date of planting.

- a. Bono. Experiments on the effects of different rates of planting made on different dates with varieties requiring different periods to mature, on the yield and quality of the crop, on the rate of growth and development, and on the number of eggs laid, the percentages of larval establishment, of infestation, and of broken stalks.
- b. Wooster, Paulding County, and Hamilton County. Duplicates of the experiments at Bono, except for modifications in the varieties and rates used and for the absence of entomological data because of noninfestation.

2. Fertility and Retardation Experiments.

Experiments on the effect on yield and quality of crop and on infestation by the European corn borer, of differences in the rate and mode of development of the plants as influenced by cultural practices and by the application of fertilizers and growth retarding substances.

- a. Bono (Productive soil). A comparison of, (1) listing, (2) applying various carbohydrates to retard early development and, (3) clipping back the corn plants at different stages of development. The effect of the treatments will be studied, both with and without delayed supplementary application of fertilizers designed to hasten development after the maximum moth flight is over.





- b. Bono (Unproductive soil). A comparison of fertilizer applications at various rates in the hill and broadcast, with and without manure, and on listed and level planted corn.
- c. Wooster. Experiments on the effect of applying fertilizers and retarding agencies to corn on yield and development. Comparisons of different sources of nitrogen for fertilizing corn. Studies of the relative response of different varieties and particularly different hybrids between self-fertilized lines to different levels of soil productivity.

### 3. Corn breeding experiments.

The corn breeding experiments will comprise the continued selection of breeding stocks and the testing of these stocks for yield and resistance to borer attack, and intensive studies of the relation of these to rate of growth and physiology of development.

- a. Bono. Comparing stocks for yield and for their possible resistance or tolerance to or escapement from borer attack. Detailed morphologic and physiologic studies of the different stocks.
- b. Columbus and Wooster. Maintaining and selecting breeding stocks and comparisons of their productiveness, quality, etc.

### 4. Physiologic experiments.

Studies on the rate and mode of growth of corn plants as influenced by differences in heredity and environment, and as related to yield and quality of crop and to moth preference, larval establishment, and final damage by the European corn borer. These experiments will be conducted largely at Bono but will be supplemented at Wooster and elsewhere as may



be desirable. The material will consist of corn plants from the various breeding experiments and from the comparisons of different rates and dates of planting cultural practices, fertilizer applications, etc. In general, the records of the breeding stocks, treatments, etc., and of the environment as obtained by measurements of temperature, humidity, rainfall, evaporation, wind velocity, sunshine, and soil moisture will form the causal background of variation.

The effects of this variation will be investigated through:

- a. Biochemical studies of the aromatic constituents of the leaves and studies of the invisible radiant energy from the plant, as possibly related to attractiveness to the corn borer moths.
- b. Determination of the growth rate during short periods.
- c. The determination of the time required to reach certain stages of development.
- d. Studies of the gross and minute structure of corn plants with special reference to variations in the vascular system, the pith and the cortex.
- e. The determination of chemical differences in plant parts with special reference to the chlorophyll content, elaboration and transformation of carbohydrates (particularly to lignification), the mineral constituents, and the carbohydrate-nitrogen relations with particular reference to their relation to the life history and development of the corn plant.



B. Investigations in lightly or noninfested areas (Cooperative with the Iowa, Nebraska, Kansas, and Missouri State Agricultural Experiment Stations, calendar year, 1929).

1. Varietal trials, combined with rate and date of planting and cultural and fertilizer experiments to determine the possibility of modifying present practices with the advent of the borer.
2. Breeding experiments to develop corn that will be productive when planted at an abnormal time.





The Forage Crop program is being carried out under two projects:

(1) Soybeans in the corn borer area. An assistant agronomist well-versed not only in agronomy but in chemistry has been appointed and cooperation has been established with the Ohio College of Agriculture and Experiment Station. A plan of work, covering the development of soy beans of high and low oil content, study of improved high yielding varieties and cultural methods, has been agreed to in conference with representatives of the Ohio College of Agriculture and the Experiment Station and those of the Bureau of Plant Industry. This plan will be carried out mainly in Northwestern Ohio on a farm near Deshler, but work will also be done at other places in the neighboring portions of the Corn Borer area.

(2) Pasture improvement. Experiments on the improvement of pastures, by the use of fertilizers and by better management have been commenced at the following places:

Beltsville, Maryland. The cooperation of both the Bureau of Animal Industry and the Bureau of Dairy Industry was secured in a comprehensive experiment on pasture improvement. An assistant agronomist has been placed in charge of the agronomic features of the work. Several series of plats have been laid out to study the effect of fertilizers, the value of different grazing plants and the value of methods of management.

Kylertown, Pennsylvania. A sixty acre tract near Kylertown, Pa., has been leased and a series of pasture experiments covering chiefly the



use of fertilizers has been laid out in cooperation with the Pennsylvania Agricultural Experiment Station. Tests of various grazing plants will be made and ecological studies will be carried on to determine the plant succession under various conditions.

Michigan. An experiment on the improvement of existing pastures, by reseeding, fertilizer, or management has been planned and will be commenced in the spring of 1929.



# BUREAU *of* PUBLIC ROADS







BUREAU OF PUBLIC ROADS



CORN BORER CONTROL PROGRAM FOR FISCAL YEAR 1930

Bureau of Public Roads

Division of Agricultural Engineering

Cooperation will be given in all control projects with the Bureau of Entomology involving the use and development of farm and other machinery. This involves the development and use of the following types of equipment:

I. Heat treatment

A. Burners

- a. Continuation of fundamental data for burner development, including tolerance of borers to dry heat, resistance to temperature changes, effect of gases of incomplete combustion, etc.
- b. Further study of nozzles, i.e., design, testing, etc.
- c. Development and testing of low-pressure mobile burners, both single-row and multiple-row jet.
- d. Development and testing of high-pressure mobile burners, both single-row and multiple-row jet.
- e. Studies of other types of burners.
- f. Continuation of burning-method studies, including incinerators and stalk-pile burners.

B. Steam

- a. Fundamental data for mobile steamer development, including tolerance of borers to steam heat.
- b. Development and testing of low-pressure mobile steamers (50 lbs. to 100 lbs. gauge pressure corresponding to temperatures of from 212° F. to 300°F.).
- c. Studies of steaming methods - field, stalk pile and barnyard.



## II. Crop remnant handling machinery

- A. Detaching or severing stalks from stubble
  - a. Poling - methods and costs
    - (1) By pole or log
    - (2) By railroad iron
- B. Road scraper blade drag - methods and costs
- C. Plank drag - methods and costs
- D. Stalk shaving - methods and costs
  - a. Sled type
  - b. Wheel type
  - c. Other types
- E. Collection of loose field debris
  - a. Side-delivery rakes - methods and costs
  - b. Dump rakes - methods and costs
    - (a and b cooperative with rake manufacturers)
  - c. Stalk pick-up machine - design and testing
  - d. Loaders
  - e. Suction pickers
  - f. Street sweeper (Fordson)
  - g. Other machines

## III. Soil working and tillage machinery

- A. Effectiveness of coverage and how affected by width and type of plow, depth of plowing, speed of plowing, treatment of stalks before plowing, attachments used on plows, soil conditions and types, and other related factors.
  - Note:- Observations are to be made periodically to record exposure of trash caused by rain, heaving by frost, and subsequent tillage operations.
- B. Effectiveness of soil working operations under IIIA, on corn borer control in:
  - a. Fall operations
  - b. Spring operations
  - Note:- These may be checked in the acre cages at the development farm.
- C. Continue studies on the draft of plows
- D. Investigate, and if practicable, formulate recommendations whereby a farmer can make do with his present equipment; for example, if a farmer has a 12" horse plow, outline a treatment of the field, (standing stalks or stubble) before and after plowing, to produce a good job of covering.





#### IV. Harvesting and processing machinery.

##### A. Adjustments, design of attachments - testing and costs with:

1. Ensilage cutters both stationary and portable
2. Single-row corn picker with stalk shredder or cutter attachment
3. Two-row picker with squeezing or other attachment
4. Husker-shredders.

(a) New machines are to be tested with special reference to affects of shredder-head speed, type of head (cutter, shredder or combination) and snapping-roll pressure.

(b) Farmer-owned machines are to be tested as found and adjusted if possible to give best results.

Note:- Stalks with three different intensities of borer infestation are to be used in a and b.

5. Balers- both shredded and whole stalks to be baled according to commercial practices in processing, and placed in cages (out of doors and under cover).
6. Low-cutting binder attachments - continued and carried on cooperatively with the manufacturers.
7. Stubble slitting attachments for standard binder.
8. Low cutting hand devices.
9. Forage grinder.

##### B. By-product utilization machinery. (May be carried on in cooperation with some state or processing company)

#### V. Methods of applying insecticides.

##### A. Extent of this work will depend upon the requirements of the Bureau of Entomology involving the following:

1. Compressed air sprayers
2. Rotary fan dusters
3. Bellows dusters
4. Power sprayers and dusters
5. Airplane dusting

#### VI. Electrical control equipment

##### A. Special machinery

##### B. Lights - different wave lengths

Note:- Where costs are to be determined, in cooperation with Bureau of Agricultural Economics.



# ILLINOIS





ILLINOIS





ILLINOIS PROGRAM OF RESEARCH ON THE EUROPEAN CORN BORER

ENTOMOLOGICAL RESEARCH

1929

I - Distribution

- A - Scouting of the eastern counties of Illinois and other areas in the State which seem most likely to become infested by the European Corn Borer. This to be carried out by the Federal Bureau of Entomology and the Illinois State Department of Agriculture. All material found suspected of being the European Corn Borer will be sent in to the Federal Laboratory or to the Entomologists of the Natural History Survey for identification.
- B - Through circulars, articles in the press, radio, and the Extension Department urging individuals to send any insects suspected of being the European Corn Borer to Urbana for identification. In case there is any doubt regarding any material sent in, it will be promptly submitted to the Entomologists of the U. S. National Museum at Washington.

II - The Effect on Infestation of Corn of Time of Planting. Infestation of Different Varieties. Work to be carried out in cooperation with the Agronomists at the Illinois plots in Ohio.

- A - An entomologist will be hired for the summer months to take complete data on the corn borer infestation in these plots, these data to include height of corn at the time of moth flight, number of eggs deposited on different plantings and varieties, larval establishment, results of infestation as they effect the vigor of the plant, the production of ears, the yield, the condition of the plant at time of harvest (whether broken or erect), the quality of the corn. These will be extended if funds permit.

III - Studies of Host Plants Other than Corn. These studies to be carried on in cooperation with the Federal Entomologists on the Illinois Plots in Ohio.

- A - As these plots are to be run on a regular three year rotation of corn, soybeans and wheat, with sweet clover in the wheat, special studies will be made of the degree of infestation in all crops used in the rotation; of the weeds in and about the field, or small rows of some special crops.

IV - Habits of the Corn Borer. Some incidental work along this line will be carried on in the Ohio Plots. This may include experiments with light traps and bait traps.

V - Natural Enemies.

- A - Studies of the amount of parasitism of all stages of the corn borer will be carried on in the Ohio plots.



B - Special studies are now being carried on at Urbana to determine the possibility of rearing large numbers of Trichogramma evanescens Wesm. This work will be planned along several lines to determine;

- a - The possibility of rearing large numbers of T. evanescens in the laboratory.
- b - The possibility of increasing the population of this egg parasite in different parts of this state, especially by liberating large numbers of adult parasites in the spring.
- c - The effect of such liberation on the numbers of this parasite in a locality from one year to another.
- d - The effect on the native insect fauna of the locality. This parasite is such a general feeder that increasing its numbers by artificial propagation may tend to decrease the numbers of desirable insects within a region.

C - Continuation of the studies of parasites of our native Smartweed Borer and other species closely related to the European Corn Borer.

VI - General Studies of Insect Infestations in the Variety, Cultural and Soil Fertility Plots in Illinois.

VII - General Studies of the Effect on Native Insects of the Cultural Practices Recommended for Corn Borer Control.



AGRONOMIC RESEARCH  
1929

I. Tests of Varieties of Corn

- A. Grow in comparative yield tests, on cooperative plots in Ohio, approximately 30 varieties and strains of corn that have either attained prominence in Illinois or bid fair to do so. These experiments are to be conducted in cooperation with the Federal Entomologists and Dr. J. R. Holbert, of the Federal Bureau of Plant Industry.
- B. Determine the yielding ability and quality of grain produced under Illinois conditions of approximately 75 varieties of corn many of which are early sorts. These studies are to be made at DeKalb in northern Illinois and at Urbana in central Illinois.

II. Time of Planting Varieties of Corn.

- A. Plant a large number of varieties of corn late to determine their comparative ability to produce a good quality of grain when so handled. This is done both at DeKalb and at Urbana.

III. Date of Planting Corn.

- A. Plant short season varieties of corn, and one standard variety as a check, at rates ranging from 1 to 6 stalks per hill to determine the rate of planting that will give maximum yields.

IV. Substitute Crops.

- A. Study the adaptation of different varieties of barley to the various sections of the State with the idea that this crop may prove a partial substitute for corn when the borer becomes serious.

V. Studies on Inbred Strains and Hybrids.

- A. Grow existing lines and hybrids of corn planted at early and late dates to determine comparative rapidity of development as indicated by dates of silking and maturity.
- B. Grow short season varieties of corn for the purpose of developing early maturing inbred strains.

VI. The Influence of Soil Treatment Practices on the Yield and Maturity of Late Planted Corn.

- A. Plant late a number of varieties of corn including a standard variety, on land receiving various kinds of soil treatment and determine the influence of the treatment on:
  - 1. Total yield.
  - 2. Quality of yield.
  - 3. Moisture content at husking time.





B. On new land.

During the coming season plots will be laid out on new land for the purpose of enlarging the field experiments having a bearing on corn borer control. These experiments will be planned to obtain information along three lines, viz.:

1. The influence of crop rotations and soil treatment combinations on the yield and maturity of late planted corn.
2. The influence of the rate and methods of applying fertilizers for yield and maturity of late planted varieties, and,
3. The influence of crop residue used in various ways on the yield and maturity of late planted varieties.



ILLINOIS PROGRAM OF RESEARCH ON THE EUROPEAN CORN BORER

Farm Mechanics Research, 1929.

Object:

The object of the study is to determine the most practical types of machinery and field practices to be used for corn borer destruction and control that will result in the most economical and efficient production of corn under Illinois conditions with corn borer infestation.

Plan:

- I. To cooperate with the Division of Agricultural Engineering of the United States Department of Agriculture in testing out new machines, new devices, and new methods that have been developed at the Experiment Station near Toledo, and found practical under Ohio conditions, and that seem to meet the requirements for Illinois conditions. It is planned to carry on this work on the University Farm and on farms out in the State.
- II. To cooperate with machinery companies and others who are interested in developing mechanical equipment for corn borer control. This will involve the testing out of new machines and devices that have possibilities for corn borer control under Illinois conditions. This may also involve the redesign and the construction of certain devices. It is planned that this work will be carried on along with that outlined under Number I.



# INDIANA







INDIANA



PROPOSED PLAN AND PROGRAM  
OF  
EUROPEAN CORN BORER INVESTIGATIONS  
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION  
LAFAYETTE, INDIANA  
1929  
ENTOMOLOGY

A. Behavior Studies with Adult Moths.

1. Relation of tropic responses to normal behavior of adults.
2. Chemotropic Studies.
  - a. Production of chemical attractants from favorite host plants.
    - (1) Distillates.
    - (2) Extractions.
    - (3) Fermentation products.
  - b. Testing of chemicals as attractants.
    - (1) Laboratory olfactometer tests.
    - (2) Field tests with bait traps.
      - (a) Number of adults attracted
      - (b) Sex of adults attracted
      - (c) Physiological condition of adults attracted, (Gravid, spent, etc.)
      - (d) Position of baits in field, height, etc.
    - (3) Practical application of attractants.
      - (a) Effectiveness
      - (b) Cost, etc.
  - c. Trap Crops. (Based on behavior studies).
  - d. Testing of chemicals as repellents.
    - (1) Laboratory olfactometer tests.
    - (2) Production of dust or other carriers or repellent.
    - (3) Field tests.
      - (a) Toxicity to various stages in life of borer.
      - (b) Plant tolerance.
      - (c) Number of applications.
      - (d) Time of application.
      - (e) Retention of repellent capacity.
      - (f) Adhesiveness.

3. Phototropic Studies.

- a. Response to natural light.
- b. Response to artificial light.
  - (1) Lights of various colors.
  - (2) Kind of light.
  - (3) Intensity of light.
  - (4) Practical use.
    - (a) Number of moths attracted.
    - (b) Sex of moths taken.
    - (c) Condition of females (Gravid, spent, etc.).



4. Thermotropic Studies.

- a. Effect on presence of moths in corn field and the movement of moths from sources of infestation.
- b. Effect on oviposition.
- c. Effect on response to other tropisms, as chemotropism and phototropism.

5. Hygrotropic Studies.

- a. Effect on response of moths to other tropisms, as chemotropism and phototropism.

6. Anemotropic Studies.

- a. Effect of air current and especially wind velocity or other tropisms, as chemotropism and phototropism.

B. Behavior Studies with Larvae.

1. Young Larvae.

- a. Hatching.
- b. Establishment.
- c. Degree of leaf feeding and governing factors.
- d. (1) Temperature.  
(2) Moisture supply, rainfall, and humidity.  
(3) Wind velocity.  
(4) Parasites, predators, etc.

2. Full-grown larvae.

- a. Migration from stalk to stalk in field.
- b. Migration downward toward ground as season advances.
  - (1) Percentage left in stubble at different heights.
  - (2) Percentage left in stubble when corn is cut at different dates.

C. Insecticides (Contact and Repellent)

1. Experimental tests.

- a. Laboratory preparation.
- b. Small field plot tests.
  - (1) Toxicity to different stages of insect.
  - (2) Plant tolerance.
  - (3) Number of applications.
  - (4) Time of application.
  - (5) Retention of lethal capacity.
  - (6) Adhesiveness.
- c. Types of insecticides.
  - (1) Contact
    - (a) Oils.
    - (b) Alkaloid poisons as liquid and dust.
  - (2) Repellent.
    - (a) Materials based on behavior studies.
- d. Carriers
- e. Adhesives

2. Field Tests.

- a. Effectiveness
- b. Cost and practicableness





## AGRICULTURAL ENGINEERING

### A. Soil working.

To find relative effectiveness of covering cornstalks, stubble and other crop remnants by:

1. Different widths of plows.
  - a. As affected by various depths of plowing.
  - b. Various attachments for plows.
    1. Shields which will cause the stalks to be placed in the bottom of the furrow.
    2. Different types of coulters and jointers.
2. Test the above as affected by previous treatment as discing (single-double), poling, rolling, culti-packing, etc.

### B. Crop Remnant Cleaning.

1. Detaching stalks.
  - a. Poling.
  - b. Mowing.
    1. Standard machine.
    2. Special cutter bar using special guards and knife.
2. Collecting stalks.
  - a. Dump rakes with attachments and changes.
  - b. Buck or finger rake.

### C. Field machinery.

1. Stalk Cutter--To study the possibilities of cutting standing stalks fine enough to enable complete coverage by plowing and determine possibilities of obtaining Corn Borer Control by this method without plowing.



## AGRONOMY

1. Variety and date of planting tests to determine relative yielding ability and adaptation to late planting of all available early varieties in comparison with a local standard variety, making plantings of all at two weeks intervals beginning at the normal planting date in each locality. In each case careful studies are made of the plant characters that may have a bearing on adaptation to corn-borer conditions.
2. Rate and distance of planting experiments with small early varieties to determine the best thickness of planting for maximum yields.
3. Experiments in fertilization to hasten maturity of late planted corn, using one of the standard early varieties planted late.



# MICHIGAN







MICHIGAN



MICHIGAN  
EUROPEAN CORN BORER RESEARCH PROGRAM

ENTOMOLOGY

Life History

Egg

Deposition

Hatching

Larva

Development

Survival

Migration

Infestation Studies

Corn and Stubble

Variety tests

Date, Rate and Space planting

Date of Harvest

Fertilizer, Topping

Parasites and Predators

Miscellaneous

AGRICULTURAL ENGINEERING

We have done and are doing some work on the following projects in connection with the corn borer in agricultural engineering. Funds have not been permitted us to do any extensive work.

1. Plowing
2. Hand methods of control
3. Low cutting in cooperation with the Corn Borer Office, Toledo.
4. Use of "T" rail and leveling devices.

AGRONOMY

Varietal tests

Breeding project

Date, Rate and Space planting

Date of Harvest

Fertilizer project

Topping project

Plowing

Physiological and Chemical Studies of corn plant



## FARM MANAGEMENT

1. A study of the changes in farming practices and farm organization in Southeastern Michigan on account of the European Corn Borer. In 1927, in four different areas, 250 farmers were visited and information obtained in regard to changes in corn acreages and numbers of livestock; in regard to changes in farm practices in preparing corn land for succeeding crops; and extra time required in the clean-up operations. This project will undoubtedly be carried on again this year.
2. Farm organization studies in the corn-borer area are being arranged for the coming year. These studies to serve as a guide in determining the most successful kind of farm organization in these areas.





# NEW HAMPSHIRE





NEW HAMPSHIRE



NEW HAMPSHIRE  
EUROPEAN CORN BORER RESEARCH PROGRAM  
ENTOMOLOGY

Life History Studies

Relative preponderance and mortality of the one-generation and  
the two-generation phase under New Hampshire conditions

Parasite Studies

Host Plant Studies





# NEW YORK





NEW YORK



## NEW YORK CORN BORER INVESTIGATIONS

AGRICULTURAL EXPERIMENT STATION, GENEVA, N. Y.

### I Distribution

Determination of the distribution of the pest in New York.

### II Control

- a Low cutting and plowing under infested corn stalks and weeds, etc.
- b The relation of the date of planting to the rate of infestation.
- c The varietal susceptibility of sweet corn to attacks by the corn borer.
- d Study of various insecticides in relation to the toxicity to the young caterpillars and the tolerance to the corn plant.

### III Life history, habits and seasonal occurrence of the corn borer with special reference to the protection of sweet corn in the western area of the state.

#### a Life history of:

- 1 pupa
- 2 adult
- 3 egg
- 4 larva

#### b Habits (larva)

##### 1 Migration

- a From soil in containers to the depth of 4, 6, 8, 10, and 12 inches
- b From corn stalks buried by plowing to the depth of 5, 7, and 9 inches.
- c From corn stalks buried during early fall, late fall and spring
- d From buried corn stalks adjacent to standing corn and weeds, debris and various objects capable of affording shelter.
- e Mortality of caterpillars during migration.
- f Natural enemies of caterpillars during migration.

##### 2 Hibernation

- a In corn and other plants and objects.
- b Mortality of caterpillars under normal conditions in corn stalks and weeds.
- c Mortality of caterpillars in buried corn stalks and weeds.

#### c Habits (adults)

- 1 Oviposition with special reference to early sweet corn.
- 2 Influence of meteorological conditions on egg laying.
- 3 Dispersion of moths of local origin and those from areas without the state.
- 4 Dispersion as indicated by surveys of corn fields in the Ontario and Erie Plains and region South of these.

### IV Host plant

List of all host plants, indicating relative susceptibility.

### V Natural enemies

- a Systematic collection of species to determine relative importance.
- b Rearing parasites and introducing into infested sweet corn areas.



# OHIO







OHIO



EUROPEAN CORN BORER PROBLEM

OUTLINE

DEPARTMENTS OF ENTOMOLOGY AND AGRONOMY  
OF  
THE OHIO AGRICULTURAL EXPERIMENT STATION

1929



## EUROPEAN CORN BORER PROGRAM

Departments of Entomology and Agronomy

of

The Ohio Agricultural Experiment Station

1929

### I. The description of the behavior of each stage of the European corn borer.

- A. This phase of the investigations consists of the description of the more important responses of the insect. Continued from 1923.

### II. An analysis of the environment.

#### A. Biotic factors.

The ecology of native parasites and predators will continue to receive attention. Mechanics, in as far as it pertains to the efficiency and practicability of clean farming practices, will receive the same emphasis in 1929 as during the past year. Investigations relative to the utility of insecticides will be continued.

#### B. Physical factors.

- 1. Nutrition. Previous, but not necessarily recent, observations and experiments have shown that there is a basic relation between soil and weather and the rapidity of corn development, and between cultural practices such as date of planting, fertilization, rotation, etc., and growth condition. Other factors being equal, the heredity of the plant also influences corn development. It is, therefore, of considerable importance to note that there is a fundamental relationship between corn development and the responses of the corn borer.

Many of the details of the relationships mentioned above are not clearly understood. The major efforts of the future will consist of a continued attempt to analyze these interrelations with special reference to details: In order to accomplish the aims set forth, plant specialists propose to continue the study of the rate of development and the morphology of the corn plant; and the distribution





of food materials inside the plant and the changes in these substances as influenced by environment and the maturity of the plant. Correlative with the physiological studies of the plant are the studies of the physiology of the insect itself.

(Certain phases of the investigation of this factor are conducted in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture).

2. Temperature and moisture. In conjunction with the study of the nutrition factor it is proposed to extend the investigations relative to the influence of temperature and moisture. It is the aim to place additional emphasis on laboratory experiments.
3. Light. The investigations relative to the influence of light on the corn borer will be continued.

### III. Ecological interpretations.

- A. Description and analysis are of little practical consequence unless followed by interpretation. However, interpretation and its corollary, prediction, are hardly possible without at least a fair knowledge of the entire ecological complex. It is proposed, therefore, to continue the study (1) of vegetation and soil types as indices of biotic habitats; (2) of the general influence of weather and climate; and (3) of the abundance of the borer in definite biotic habitats.

(The study of vegetation types is being conducted cooperatively with the Department of Botany of the Ohio State University and that of soil types with the Bureau of Chemistry and Soils of the United States Department of Agriculture).



# PENNSYLVANIA





PENNSYLVANIA



CORN BORER RESEARCH - PENNSYLVANIA STATE COLLEGE - 1929

ENTOMOLOGY

I - Distribution.

- A - The factors influencing intensity of infestation. A continuation of studies begun in 1928 of the infestation in northwestern Pennsylvania in its relation to the planting date, variety and growth of corn, soil type, and weather conditions.
- B - The life history and seasonal occurrence of the insect in central Pennsylvania.

II - Control.

A - Insecticides.

- 1 - Laboratory trials of various materials against eggs and young larvae; continued from 1928.
- 2 - Cost versus efficiency in corn borer clean-up. A continuation of work begun in 1928.

AGRICULTURAL ENGINEERING

The Farm Machinery Department to cooperate in the study mentioned under Entomology II (A-2).

AGRONOMY

This department to cooperate in the study mentioned under Entomology I (A).





# JOINT COMMITTEE ON THE EUROPEAN CORN BORER



APPOINTED BY  
AMERICAN FARM ECONOMIC  
ASSOCIATION

AMERICAN ASSOCIATION  
OF ECONOMIC ENTOMOLOGISTS

AMERICAN SOCIETY OF  
AGRONOMY AND

AMERICAN SOCIETY OF  
AGRICULTURAL ENGINEERS



JOINT COMMITTEE ON THE EUROPEAN CORN BORER,  
appointed by  
AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS,  
AMERICAN SOCIETY OF AGRONOMY,  
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS, and  
AMERICAN FARM ECONOMIC ASSOCIATION,  
(1928).



## REPORT OF THE JOINT COMMITTEE ON THE EUROPEAN CORN BORER

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The European corn borer, which was first discovered in New England in the summer of 1917, has continued its natural spread until at the present time (September, 1928) the insect occurs throughout more than 230,000 square miles of territory in North America including the whole or parts of the New England States; and New Jersey, New York, Pennsylvania, West Virginia, Ohio, Michigan and Indiana; and parts of the provinces of Ontario and Quebec, Canada. Vigorous measures have been taken to prevent long-distance spread by artificial means. This effort has been successful. The only known spread of any importance in the United States, therefore, has been by the natural flight of the corn-borer moths or by water-drift of infested material. This spread has been at an average rate of from 20 to 30 miles per year. From any information now available there appears to be no practicable means of preventing this natural spread.

The results of the extensive studies of the borer in this country and in Central Europe furnish convincing evidence that the insect is of tremendous potentiality and ranks as one of the most alarming crop pests ever introduced. The situation, presenting, as it does, the possibility of a national calamity, calls for the continued cooperation of the farmer, the scientist, the educator, and all State and Federal administrative officials.

The intensity of infestation by the corn borer in the western area has increased steadily since its discovery there in 1920. Before clean-up practices were applied in Kent and Essex Counties, Ontario, severe commercial damage was suffered, and this resulted in a large reduction of corn acreage. Since clean-up practices have been applied in that district there has been a decrease in the intensity of infestation and an increase in acreage. This is a hopeful indication of the effectiveness of control measures and the possibility of continued corn production under conditions thought to be most favorable to the borer.

The cooperating committee of entomologists, agronomists, agricultural engineers, and agricultural economists wishes to indorse most heartily all efforts to control the corn borer, and to commend all persons engaged in the research, regulatory, and educational activities.

The committee recognizes the necessity for the fullest development of the research, educational, and quarantine programs of the State and Federal Governments and earnestly recommends the appropriation of the funds





necessary to maintain and expand these activities. However, the committee does not favor a large Federal appropriation for a compulsory clean-up campaign for the following reasons: (1) The break in the continuity of the clean-up program in 1928 due to the failure of the appropriation for this purpose; (2) the impossibility of securing an appropriation in time for an effective clean-up to protect the crop of 1929; (3) the impracticability of enforcing effective clean-up measures under present state laws.

After careful and complete investigation of the corn-borer regulatory, research, and educational activities, the committee suggests and recommends:-

1. That the State and Provincial Agricultural Experiment Stations, and State Departments of Agriculture, and all other agencies interested in the welfare of American agriculture, give their support and encouragement to the Federal Governments of the United States and Canada in their policies on quarantine activities. Scouting should be continued in the areas contiguous to known infected areas and extended to the large corn-producing States where areas seem particularly exposed to infestation. Ample Federal funds should be available for a thorough clean-up of isolated infestations.

2. That major efforts in corn borer research, control, and educational activities be directed toward making possible the maintenance of our present corn acreage, in view of the economic importance of corn and the present advantages which this crop holds over any alternative crop as a revenue producer in the Corn Belt, and the certainty that farm incomes will be greatly reduced unless this is accomplished.

3. That the corn breeding program to produce strains that may be resistant or tolerant to the corn borer, or which may escape attack, should be continued.

4. That soil and cultural practices that may avoid reduction in yield and quality of corn by the corn borer, such as time, rate, and method of planting, soil fertility treatments, and retardation studies, should be investigated further.

5. That studies should be continued on the physiology and morphology of the corn borer and its hosts, especially the corn plant, in relation to infestation, establishment, and damage and to the yield of corn.

6. That there be continued on many fields distributed over the area of heavy infestation, the study of the relation of corn borer infestation to time of planting, variety, soil type, height at the peak of moth flight, earliness of maturity and yield of corn.

7. That the study of the ecology of the corn plant be extended to the entire Corn Belt and that similar studies of the corn borer be



extended as the spread of the insect permits.

8. That experiments on the long-time effect of various clean-up practices on soil productivity be continued.

9. That attention be given to studies of the possible substitution of other profitable crops for part of the corn acreage in the rotation in those sections where the corn borer promises to become a destructive pest. Such studies should include specifically the present and probable future market outlook for these substitute crops.

10. That studies should be made on reduction in yield or increased cost of crops other than corn, through changed methods as a result of the advent of the corn borer.

11. That efforts to determine the reduction in yield and quality of corn resulting from different densities of borer population, should be continued and enlarged to include determinations of such damage at different degrees of soil productivity. Such information is essential to reliable recommendations as to varieties, cultural practices, and possible substitute crops for corn, as well as in determining the clean-up practices that will be profitable.

12. That detailed cost-account work should be done, both within and outside of the infested areas, for the purpose of determining the costs of different farm operations, to serve as a basis for recommending changes in practices if they should become necessary.

13. That the important projects now under way to introduce and establish parasites of the corn borer from foreign countries, be continued and enlarged. It also is recommended that all such initial introductions of parasites, predators, entomophthorous fungi and bacterial diseases from foreign countries be entirely under the direction and supervision of the United States Department of Agriculture or the Department of Agriculture for Canada.

14. That continued studies should be made of the habits, life history, and environmental influences affecting the spread of the corn borer and intensity of infestations, also upon the limitations of corn as to its seasonal, varietal and cultural practices. Such information is essential to combating the corn borer and will assist the entomologists, agronomists and engineers in the development of controls.

15. That the experiments and demonstrations to determine the value of plowing under corn residues as a means of destroying the corn borer should be continued. These studies should include a determination of the comparative value of fall and spring plowing in different types of soil, with





different widths and types of bottoms, on different dates, and at various depths.

16. That the experiments in the large screened areas should be continued to determine the relative degrees of infestation and damage to be expected, (a) where no effort at clean-up is made and (b) where the most practical clean-up methods are employed.

17. That investigations upon insecticides, repellents and attractants be continued.

18. That in one-generation areas the study of weeds and plants other than corn be continued to determine what part these may play in the future as breeding hosts of the borer, especially in districts where, owing to the severity of the infestation, corn growing may be reduced temporarily.

19. That in view of the interdependence of machinery requirements and design, intensive development work should be continued. The experimental and research programs should be correlated with control methods and large-scale field procedure.

20. That the control of the corn borer by mechanical means is of demonstrated importance and undoubtedly will continue to be so as long as the pest remains a menace to the corn crop of the country and therefore comprehensive and vigorous research programs relating to mechanical operations of crop production and commercial utilization should be continued by state and federal agencies.

21. That the machinery development program which is being conducted by state and federal agencies along crop production and utilization lines be continued. Since no one method or machine is adapted to all conditions, it is recommended that more complete information be made available in regard to cost and effectiveness of using rakes, burners and other stalks and remnant disposal machinery and other devices to reduce hand labor.

22. That studies be made to determine the effects on farm incomes of different methods of harvesting and utilizing corn stalks, both commercially and on the farm.

23. That radical changes in agricultural practices should be recommended only if justified by the results of economic surveys including farm cost records.

24. That the State and Federal extension agencies take every opportunity by demonstrations, exhibits, and lectures to acquaint their constituencies with the gravity of the corn-borer problem, the nature of the insect and its work, and the methods of meeting the situation. The need of



the cooperation of every grower in the regions adjacent to the infested area as well as within recognized corn-borer territory should be emphasized.

25. That Federal and State administrative authorities be urged to make available at frequent intervals up-to-date information regarding the general situation and the progress of investigations in the United States, Canada, and abroad, through the medium of bulletins, circulars and leaflets. Also, where advisable, mimeographed statements of progress be issued at frequent intervals to technical workers.

26. That the committee act as a clearing house in advancing corn borer control measures by obtaining opinions from the entomologists, agronomists, agricultural engineers, agricultural economists and others, as to the lines of research and other methods which should be pursued, with special reference to needed investigations not now under way and which may have a practical application to the problems.

27. That the fullest program of research be conducted along all lines offering promise of assistance and the fullest financial support for such research programs be provided, research being recognized as the basis of all progress in methods of control of the corn borer.

28. It is recommended that copies of all written reports or recommendations of the committee be made available to the Secretary of the United States Department of Agriculture and the Minister of Agriculture for Canada.

Respectfully submitted,

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L. Caesar  
D. J. Caffrey  
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Sept., 1928.





Report of the Committee on Allocation

(1928)



THE REPORT OF THE COMMITTEE OF ALLOCATION ON  
THE EUROPEAN CORN BORER RESEARCH WORK

The Committee on Allocation not only accompanied the European corn borer committees appointed by the American Association of Economic Entomologists, the American Society of Agronomy, the American Association of Agricultural Engineers, and the American Farm Economic Association on their annual tour of inspection of the corn borer research work in Ohio, Michigan, and Ontario, but also met with the joint committee and assisted in preparing the annual report of the joint committee on the European corn borer. This gave the Allocation Committee an excellent opportunity to become acquainted with the many phases of the corn borer research work. It is the unanimous opinion of the committee that while there is some duplication of the research work by the various Government and State workers, there is no unnecessary duplication.

The recommendation of the Allocation Committee that all initial introductions of parasites, predators, entomophthoraceous fungi and bacterial diseases from foreign countries be entirely under the direction and supervision of the United States Department of Agriculture or the Department of Agriculture for Canada, was approved and included in the report of the joint committee on the European corn borer.

The committee would like to make the following suggestions:

1. That the corn borer workers come to some definite agreement or understanding as to what is meant by such terms as larval establishment and larval survival, and use with care as to their accepted meaning such terms as fodder, stover, knife, blade, stalk, plant, etc.



2. That the Director of Scientific Work appoint as an additional member of the Allocation Committee, a Plant Ecologist, in order that the ecological surveys and investigations relating to corn borer research work might be closely tied up with the other cooperative work on the corn borer.
3. That all European corn borer investigations made in foreign countries by workers of the United States should be with the approval of the Director of Scientific Work of the United States Department of Agriculture.







